INSTRUCTION
BOOK

for

MONROE ADDING-CALCULATOR

Series 3
KA

INSTRUCTION BOOK

MONROE
Adding-Calculator
Series 3 KA Models

MONROE CALCULATING MACHINE CO., INC.
ORANGE, NEW JERSEY

Sales and Service Available in all Principal Cities of U. S. A.
and Throughout the World

FOREWORD

THIS book is designed to enable even inexperienced operators to use the Monroe Adding Calculator to the best advantage.

The instructions are made extremely simple so that they will be understood by beginners who may never have used an adding or calculating machine, and enable them to add, subtract, multiply, divide and work out all ordinary commercial problems without other assistance.

Part I gives instructions for performing the fundamental arithmetical operations—addition, subtraction, multiplication and division; with rules for handling decimals. Part II describes easy methods for solving certain types of problems and the use of various short-cutting operations.

Examples are given to show the wide adaptability of the Monroe and its effective application to modern office figuring work. No attempt, however, is made to describe all of the many uses of the machine, which will handle any kind of figure problem regardless of how complicated it may be.

Further instructions in the use of the Monroe and its applications to special lines of work will gladly be given if you will get in touch with either the nearest local Monroe office or write to the General Offices of the Company at Orange, New Jersey.

Have the Machine Before You and Use It
As You Read the Instructions

The easiest and most natural manner of operating the Monroe is as follows:

Place the machine on the desk directly in front of you, turned at a slight angle.

Use fingers of right hand to depress keys. If the amounts are large both hands may be used to set the figures on the keyboard.

With the right hand operate plus and minus bars and dials clear-out crank. Left hand is free to follow work and to operate carriage shift lever.

The dials clear-out crank needs but one turn in either direction for clearing. Always complete either the forward or backward revolution of the clear-out crank to the bottom of the turn.
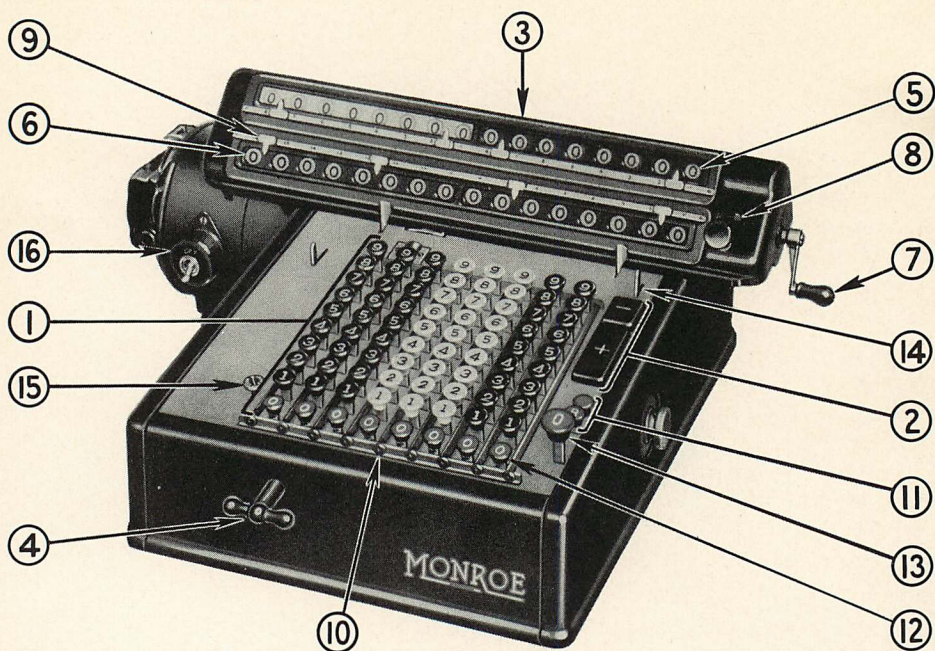
Figure 1

Monroe Model KA-163

1 Keyboard
2 Plus and minus bars
3 Carriage
4 Carriage shift lever
5 Upper dials
6 Lower dials
7 Dials clear-out crank
8 Upper dials control lever
9 Decimal markers on dials
10 Decimal markers on keyboard
11 Repeat and non-repeat keys
12 Zero keys
13 Clear key
14 Upper dials reversing lever
15 Item counter
16 Motor

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MONROE INSTRUCTION BOOK

PART I

Various Parts of the Machine and their Operation

The Monroe Adding-Calculator, as its name implies, is an adding and calculating machine, capable of performing the four fundamentals of arithmetic, addition, subtraction, multiplication and division; with accuracy, speed and simplicity.

It may best be described briefly in a manner for easy understanding by mentioning its three principal parts—a standard keyboard (1 in Fig. 1) for setting up the numbers to be added, subtracted, multiplied or divided; the plus and minus bars (2), or crank in hand model, at the right of the keyboard for performing the operations; and the carriage (3) at the top of the machine holding the dials which register the results and proofs of the various operations as they are performed.

The Monroe is manufactured in three distinct models, the Series "0", "1" and "3", all operating under the same basic principles of a forward movement for addition and multiplication, and a reverse movement for subtraction and division.

On the Electric models addition and multiplication are accomplished by use of the plus bar, subtraction and division by use of the minus bar. Any Electric model Monroe may be operated with the same ease as any hand model by the insertion of the hand operating crank.

On the hand models the operations are performed by use of the hand crank, conveniently located at the right of the keyboard; a forward turn for addition and multiplication, and a backward turn for subtraction and division.

The principles of operation are the same for all models of Monroes. To illustrate the operation of the Monroe in the following instructions the model KA-163 has been used. These instructions, however, are applicable to any other Monroe Model.

If learning to operate a hand model these instructions should be followed out in the same manner, excepting where reference is made to the plus bar, the hand operating crank must be operated in a forward turn, and where the minus bar is referred to, the crank must be operated in a

backward turn. Complete forward or backward turns of the hand operating crank should always be made, otherwise the machine becomes automatically locked to guard against operating errors. The stopping place, or neutral position of the crank, is designated by an arrow on the right of the keyboard opposite the crank.

In the following descriptions of the parts of the Monroe the numerals refer to the key numbers on page 4:

(1) Keyboard

The Monroe keyboard is the standard flexible type. By depressing the keys amounts to be added, subtracted, multiplied or divided are set up. The depressed keys enable the operator to read the amounts as they are set up—an error may be detected and corrected immediately by simply depressing the proper key. This operation automatically restores the key which has been incorrectly depressed in the same column.

(2) Plus and Minus Bars

The plus bar is used for the forward operation of the machine as in addition and multiplication.

The minus bar is used for the reverse operation of the machine as in subtraction and division.

(3) Carriage

The carriage may be moved to right or left as required. The figures in the dials are always in vertical alignment with the figures on the keyboard; thus, a depressed key in any column will operate the dial in the carriage directly above it.

(4) Carriage Shift Lever

The carriage may be instantly shifted to the left or right as desired by a half turn of the carriage shift lever.

If it is desired to shift the carriage a number of places, it may be raised by the hand shifting knob on the right end and moved the number of spaces required.

(5) Upper Dials

The upper dials show the multiplier in multiplication and the quotient in division.

In the Series "0" and "1" models there is a single set of upper dials that register multipliers in black figures and quotients in red figures.

In the Series "3" models there are two sets of upper dials; the right upper dials registering in black figures only and the left upper dials registering in black and red figures. The right upper dials register multipliers; having a tens-carry mechanism they permit short-cut multiplication and serve as an item count in addition. The left upper dials register multipliers in black figures and quotients in red figures; combinations of both black and red figures are used in special work. Single multipliers or quotients may be registered in left upper dials and accumulated multipliers or quotients in right upper dials. Both sets of upper dials operate simultaneously.

(6) Lower Dials

The lower dials show the result in addition and multiplication, the remainder in subtraction and the dividend in division.

(7) Dials Clear-Out Crank

A forward turn of the dials clear-out crank clears the upper dials and a backward turn clears the lower dials.

(8) Upper Dials Control Lever

In the Series "3" models both sets of upper dials clear simultaneously unless the upper dials control lever is pushed to the left position, when the left dials only clear and accumulated amounts remain in the right upper dials.

(9) Decimal Markers on Dials

These movable markers are set in advance for the number of decimal places required for the work in hand.

(10) Decimal Markers on Keyboard

These markers between the columns of the keys are turned over by means of knurled knobs, showing white to indicate the position of the decimal point on the keyboard. Like those on the dials they have no mechanical connection with the working parts of the machine, being used simply as an aid to distinguish the location of the decimal points.

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(11) *Repeat and Non-repeat Keys*

When the repeat key is depressed the figures set on the keyboard remain locked until cleared by the operator. When the non-repeat key is depressed the keyboard clears after one revolution of the machine. Repeat key must be depressed when performing multiplication and division.

(12) *Zero Keys*

The zero keys clear any column of keys without disturbing the "set-up" in other columns. They also assist the operator in seeing at a glance in what columns figures are set.

(13) *Clear Key*

Depressing the master clear key clears the entire keyboard and depresses all zero keys.

(14) *Upper Dials Reversing Lever*

On the Series "3" models when this lever is pushed forward into ÷ position the direction of rotation of the upper dials is reversed. It is only used in involved calculations and for ordinary work should be kept in down, or x, position.

(15) *Item Counter*

In a series of additions on a Series "3" model the number of items added appears in the right upper dials. On Series "0" and "1" models when the item counter is turned to the right (with arrow pointing toward the keyboard), the "one" key in the last column is held down and the number of items added is counted in the lower dials above this "one" The operator should guard against having this item counter hold down the "one" key in performing other operations.

(16) *Motor*

The Monroe Electric is equipped with the Automatic Start and Stop Motor. When operating the machine the motor switch is turned "on" although motor only runs when the plus or minus bar is depressed, making an electrical connection.

Operations of Addition, Subtraction, Multiplication and Division

Addition

Though addition may be accomplished with the carriage in any position, it is best when performing the simpler operations to have the carriage shifted to the left as far as it will go as shown in Figure 2.

Addition is best accomplished by the "Locked Figure" method, that is, with the repeat key depressed.

Example: $325 + 456 + 222 = 1003$

Set 325 on the keyboard, and touch the plus bar; the machine makes one revolution, and the 325 appears automatically in the lower dials. Set 456 on the keyboard, touch the plus bar, and the 456 is added to the 325 in the lower dials. Set 222 on the keyboard and again touch the plus bar, registering the result 1003 in the lower dials as shown in Figure 2. Right upper dial shows a 3, the number of items added.
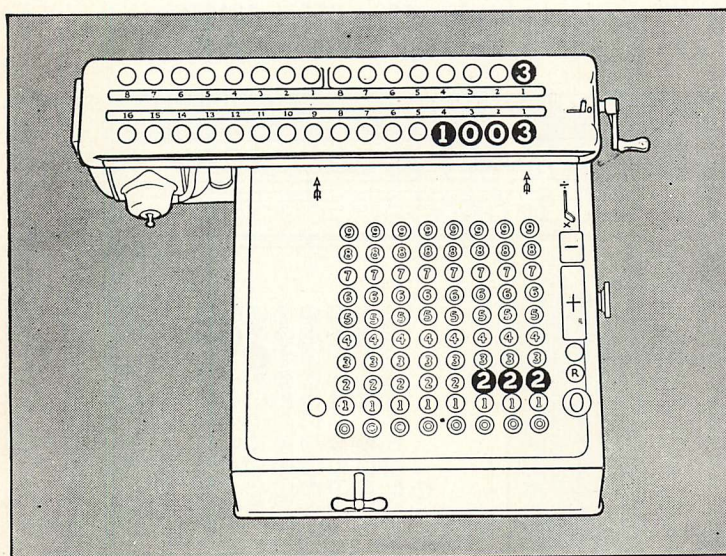

Figure 2

When familiar with this principal of operation the operator should practice the method of Monroe Short-Cut Addition—simultaneous depression of keys and plus bar. The figures to be added are set on the keyboard with the fingers of both hands and at the same time the plus bar is

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depressed, the amount registering instantaneously in the lower dials. Thus the necessity of having to make the key depressions first and then depressing the plus bar as a separate operation is eliminated.

Subtraction

On the Monroe subtraction is a direct operation. The larger number is set on the keyboard and turned into the lower dials by a touch of the plus bar. Next the smaller number is set on the keyboard. A touch of the minus bar causes a reverse revolution of the machine and the smaller number is subtracted, the difference showing in the lower dials.

Example: $1003 - 325 = 678$

At the end of the example in addition 1003 appears in the lower dials. To subtract 325, simply set 325 on the keyboard and touch the minus bar, and the answer 678 appears in the lower dials.

Subtraction is also performed by reversing this process, *i.e.*, first, with the dials cleared, the smaller number is subtracted from zero, then the larger number is set on the keyboard and added.

Multiplication

Multiplication on the Monroe is as simple as addition. It is accomplished by setting one number on the keyboard and writing the other number in the upper dials by means of the plus bar.

Example: $789 \times 234 = 184626$
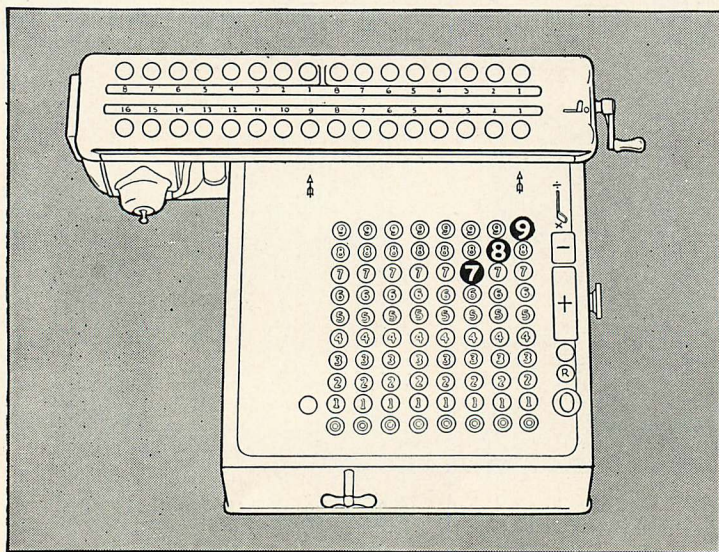
Set up 789 on the keyboard as shown in Figure 3.

Figure 3

Hold the plus bar down until the machine makes four revolutions and 4 appears in the upper dials. With the carriage shifting lever, shift the

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carriage one position to the right, hold the plus bar down until the 3 appears to the left of the 4, then shift the carriage again to the right, hold the plus bar down until the 2 appears to the left of the 3. The keyboard and dials are now in the position shown by Figure 4.
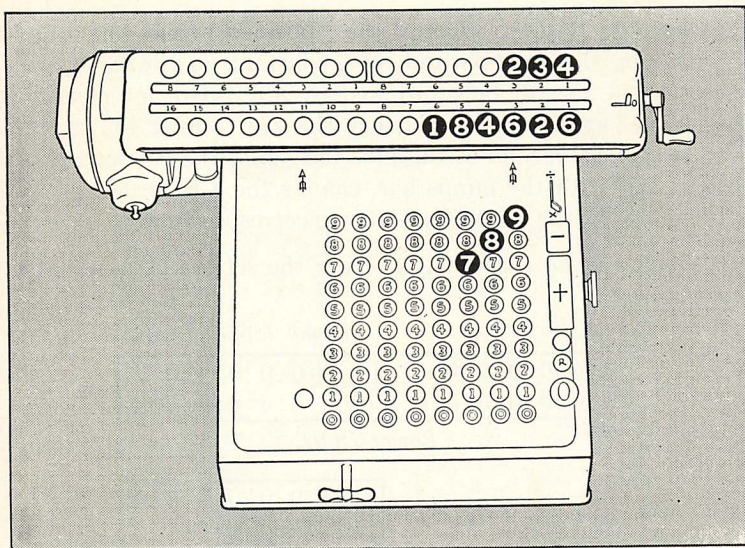

Figure 4

At the completion of the example, the right upper dials read 234, the multiplier; the lower dials, the answer, 184626; and the keyboard the multiplicand, 789. This is a complete and positive proof of accuracy.

Notice as these operations are being performed that the multiplier always registers in the upper dials directly over the arrow on the keyboard. Keep this in mind as it is this point that determines how the carriage must be shifted in order to register the digits of the multiplier in their proper positions. For simple multiplications on the Series "3" read the multiplier in the right-hand upper dial.

In multiplying if the plus bar is held down too long and a number that is greater than the desired multiplier appears in the upper dials, hold the minus bar down until this figure is reduced as much as necessary to make it the correct number. Similarly if a figure of the multiplier in the upper dials is found to be less than the desired number, due to not holding the plus bar depressed long enough, depress the plus bar again until this figure is increased as much as necessary to make it the correct number. In other words, if it is discovered that the wrong number of revolutions

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have been made at any step it shows in the right upper dials and may be immediately corrected by either forward or backward revolutions, as the case may require, without doing the problem over.

Changing the Multiplier

Suppose you wish to change the multiplier from one number to another leaving the multiplicand, 789, constant on the keyboard. For instance, 789 is also to be multiplied by 432. Do not clear machine and begin over again. Simply change the 234 to read 432 by changing the 2 to read 4 by means of the plus bar, shift the carriage two places to the left, and with the minus bar, change the 4 to read 2. As this is done the figures in the lower dials change correspondingly.

The result in the machine, ignoring the left-hand upper dial, will read as follows:

Right Upper Dials

0 0 0 0 0 0 0 0	0 0 0 0 0 **4 3 2**
0 0 0 0 0 0 0 0	0 0 **3 4 0 8 4 8**

Lower Dials

0 0 0 0 0 **7 8 9**
Keyboard

The entire operation is extremely simple; it requires no expert knowledge, skill, or training, and you know your result is absolutely accurate because all the numbers you have used are visible in the machine.

Multiplication on the Monroe may be performed in either direction. For example, in the above multiplication (789 × 234) you may begin as explained by multiplying first by the 4 units in the multiplier, shifting the carriage to the right to put in the 3 tens and the 2 hundreds; or you may begin by turning in the 2 hundreds in the third position in the upper dials, shifting the carriage to the left to put in the 3 tens and the 4 units. The result will be the same in either case; as long as the multiplier reads correctly the answer is bound to be accurate.

Division

On the Monroe, division is performed with the same ease, simplicity and directness as multiplication. As multiplication is a process of continued additions and is accomplished by the use of the plus bar, so division is a process of continued subtractions and is accomplished by the use of the minus bar.

Example: 477591 ÷ 224 = 2132, remainder 23

Set the dividend, 477591, in the keyboard and with one touch of the plus bar register it in the lower dials. Clear the upper dials and keyboard. Set the divisor, 224, on the keyboard and shift the carriage three spaces to the right so as to bring the divisor, 224, directly under the 477 of the dividend, the first position for dividing.
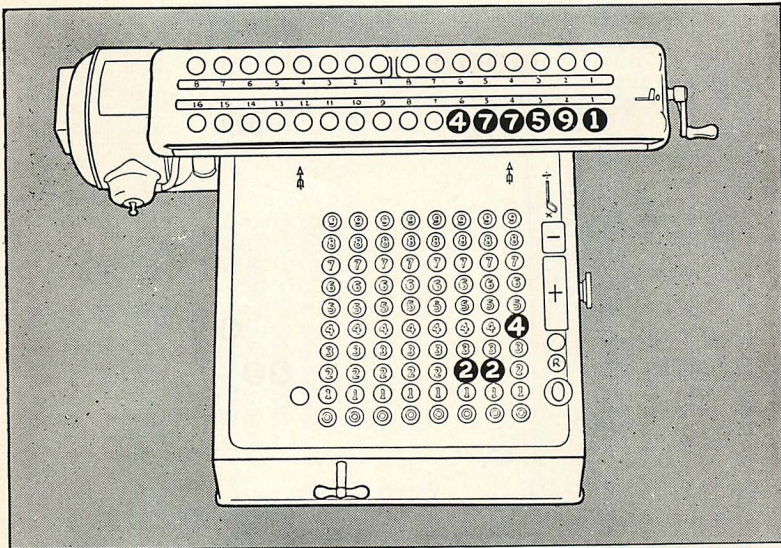
The machine at this point is as shown in Figure 5.

Figure 5

Hold the minus bar down until the machine stops, then touch the plus bar. The red 2 in the left upper dials indicates the first figure of the result, as shown under the first step on the next page.

Shift the carriage one space to the left again, hold the minus bar down until the machine stops, then touch the plus bar. The result will be a red 1. See second step. Continue this operation with the minus and plus bars, and the shifting. At the completion of the problem, the quotient, 2132, will appear in the left upper dials and the remainder, 23, in the lower dials.

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The figures as they appear on the machine at the end of each step are as follows:

	First Step	Second Step	Third Step	Last Step
Left upper dials	00002000	00002100	00002130	00002132
Lower dials	00029591	00007191	00000471	00000023
Keyboard	00000224	00000224	00000224	00000224

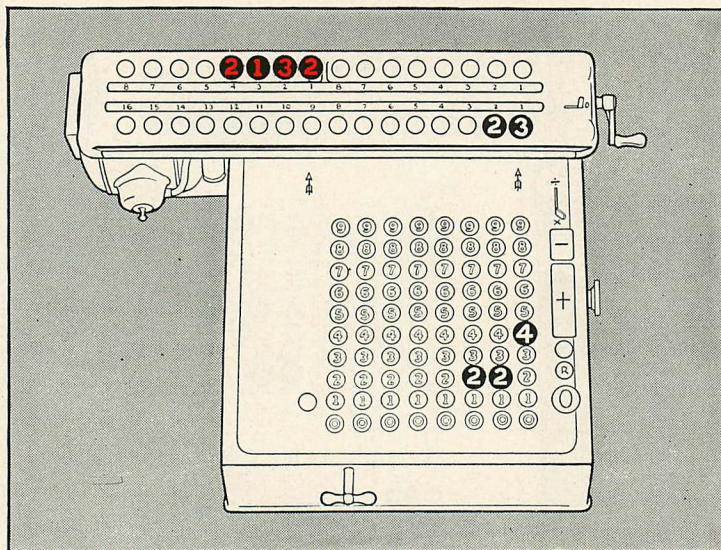The machine at this point is as shown in Figure 6.

Figure 6

The whole operation requires but three or four seconds. In simple division, ignore the figures which appear in the right upper dials.

If operating a hand machine, and at any stage of the division, too many backward turns of the crank are made, a row of nines is brought up at the left of the dividend, and a bell rings, instantly indicating the extra turn. To correct this, merely turn the crank forward, bringing all the figures back just as they were before the extra turn was made. Again the bell rings, indicating that the correction has been made. Shift carriage to left and continue division by subtracting.

The Use of Decimals
and Rules for Pointing Off

Multiplication of Decimals

The arrangement of the dials and the keyboard in the Monroe machine makes it particularly adapted to the handling of calculations involving decimals. The use of "fixed" decimal points is strongly recommended for all work of this kind. By the use of fixed decimal points we reduce the whole matter of multiplying decimals to one simple rule, the ordinary arithmetical rule for handling decimals, that is to mark off as many places in the result as there are decimal places in the other two factors combined.

On the Monroe machine in multiplication the result dials are the lower dials and the two factors are shown in the upper dials and the keyboard, respectively. Hence our rule as applied to the Monroe machine for multiplication of decimals would be as follows:

First, having determined from the given factors the greatest number of decimal places that must be provided for, fix the decimal points on the keyboard and on the upper dials with a sufficient number of places to accommodate those factors. Then fix the decimal place on the lower dials at the sum of the places as they have been fixed on the upper dials and keyboard. Always keep this balance in decimal places.

Remember it as a formula for decimal points as follows:

Upper dials + Keyboard = Lower dials

That is, the number of decimal places on the lower dials is always the total of the decimal places on the upper dials *plus* the decimal places on the keyboard.

Then proceed with the multiplication, being careful to set the multiplicand on the keyboard with proper relation to the keyboard decimal point as it has been fixed (whole numbers are set to the left of the marker and decimals to the right), shift the carriage if necessary, to such a position that when the multiplier is being turned into the upper dials it will be registered in the proper relation to the upper dials decimal point as it has been previously fixed. You can then be sure without question that the result as it appears in the lower dials will be properly pointed off by the fixed decimal point which has already been established on those dials.

Example: 20.125 x .425 = 8.553125

In this problem the largest number, 20.125, or the multiplicand, is to be set up on the keyboard. This means that we must mark off three decimal places on the keyboard to accommodate it, turning over marker between the third and fourth columns of keys. The .425 is to be turned

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into the upper dials. Therefore three places must be pointed off on the upper dials to accommodate the multiplier. We now have three places pointed off on the keyboard and three places pointed off on the upper dials. We must, therefore, fix the decimal slide on the lower dials at the sum of three and three or six places.

Set up the 20.125 on the keyboard with proper relation to the keyboard decimal point, shift the carriage as may be necessary and hold the plus bar down so as to register the 5, and 2 and the 4 of the multiplier in the upper dials in the proper relation to the fixed decimal point which has been established there. The result will then show as in Figure 7.
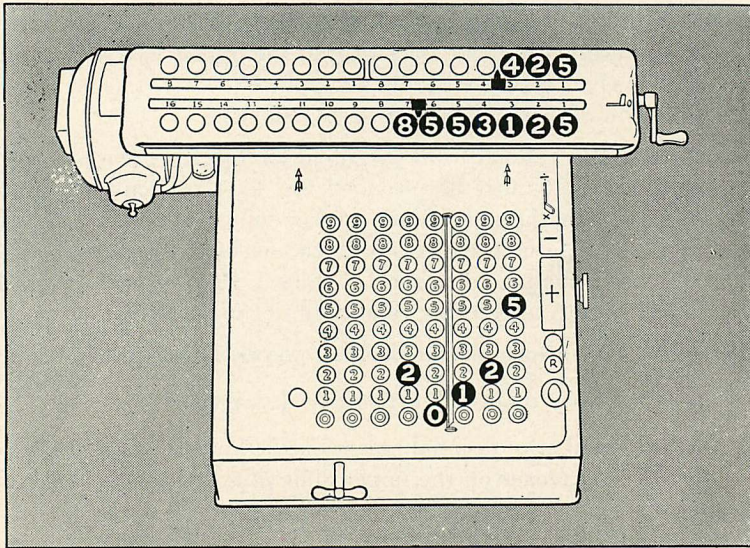

Figure 7

Division of Decimals

In division the same principle of pointing off applies. That is, the sum of the decimal places on the upper dials and the keyboard must always show on the lower dials.

Example: 22.868 ÷ 6.7 = 3.4131

Quotient is desired to four decimal places. Since the quotient is going to be shown in the upper dials and is to be carried out to four decimal places, we start out by fixing the decimal point on the left upper dials with four places to the right.

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The divisor, 6.7, is going to be set up on the keyboard. Therefore, we need to use but one decimal place on the keyboard.

Suppose, however, that we decide to leave the decimal place fixed on the keyboard at the same place it was in the previous problem, that is, with three places to the right so as to accommodate any divisor containing from one to three decimal places. This means that having the decimal point fixed at four places on the upper dials and three places in the keyboard, it must be placed at the sum of four and three, or seven places on the lower dials.

We must now get the dividend into the lower dials. To do this, set the dividend, 22.868, on the keyboard and turn it into the lower dials with a touch of the plus bar, so that it shows in the lower dials properly pointed off as shown in Figure 8.

As the dividend is turned into the lower dials, a 1 is registered in the upper dials. Always clear this 1 from the upper dials before proceeding with the division. The easiest method is first to clear the keyboard by means of the master clear key, then touch minus bar so that machine makes one reverse revolution. See "Speeding up Division" on page 20.

Set 6.700 on the keyboard and shift the carriage to the proper position for the first subtraction, see Figure 8.
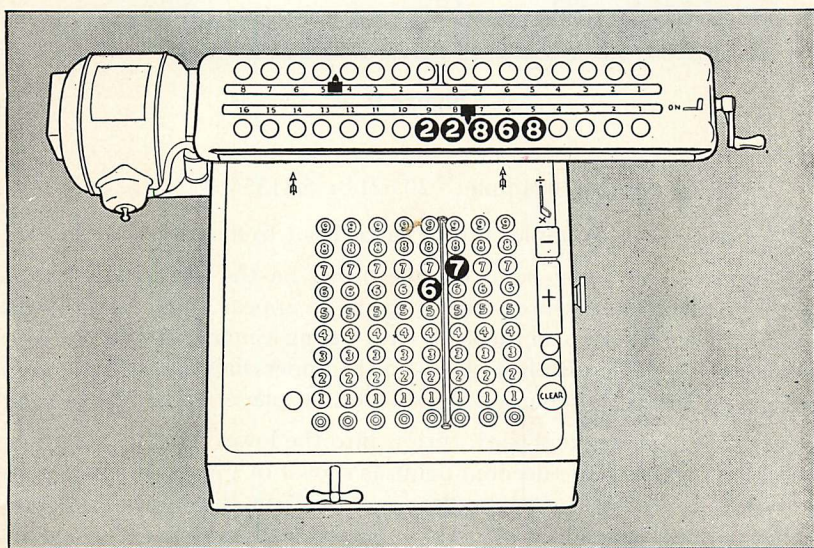

Figure 8

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Continue the operation as in simple division previously explained by holding the minus bar down until the machine stops. Touch the plus bar and shift the carriage toward the left.

As the result is being registered in red in the upper dials it will automatically register with proper relation to the decimal point which was previously fixed and the final result will show as in Figure 9. The .0002300 shown in the lower dials is the remainder.
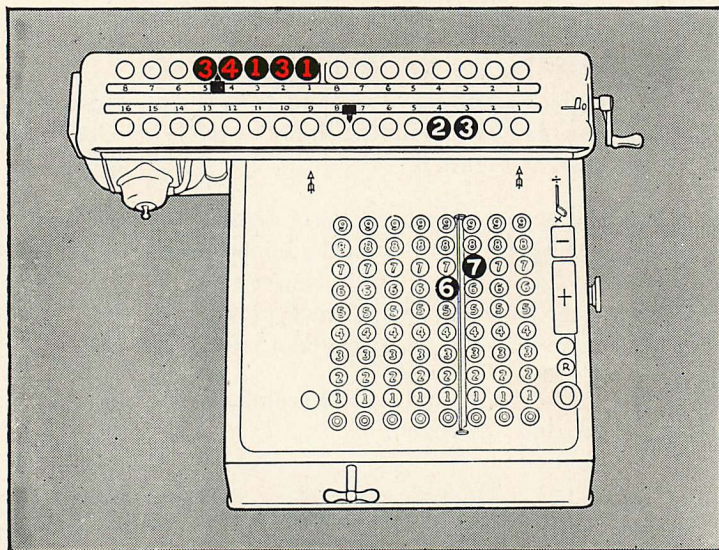

Figure 9

Take another example: 20.621 ÷ 6.41356 = 3.21521

Quotient in this example is to be carried out to five decimal places.

This means we must point off five places on the left upper dials as that is the place where the quotient is going to appear. Since the divisor, 6.41356, must be set up on the keyboard, we must mark off five places on the keyboard. Now with five places on the upper dials and five places on the keyboard, we must point off the sum, or ten places on the lower dials.

Set 20.621 on the keyboard, turn it into the lower dials in the proper place with regard to the decimal point as shown in Figure 10. Clear the keyboard and do not forget to clear out the 1 in the upper dials after turning in the dividend. Set 6.41356 on the keyboard as indicated and shift the carriage to the proper position to start the division as shown in Figure 10.
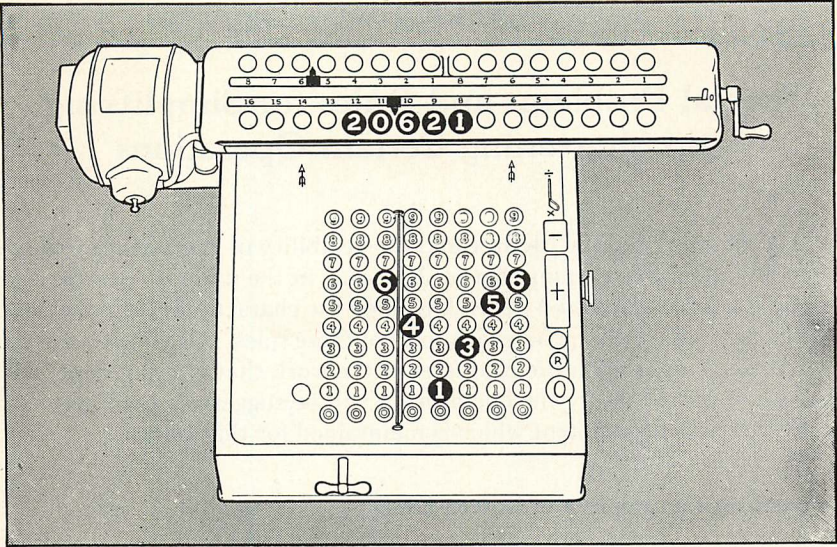
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Figure 10

Proceed with the division in the regular way, showing the final result as in Figure 11.

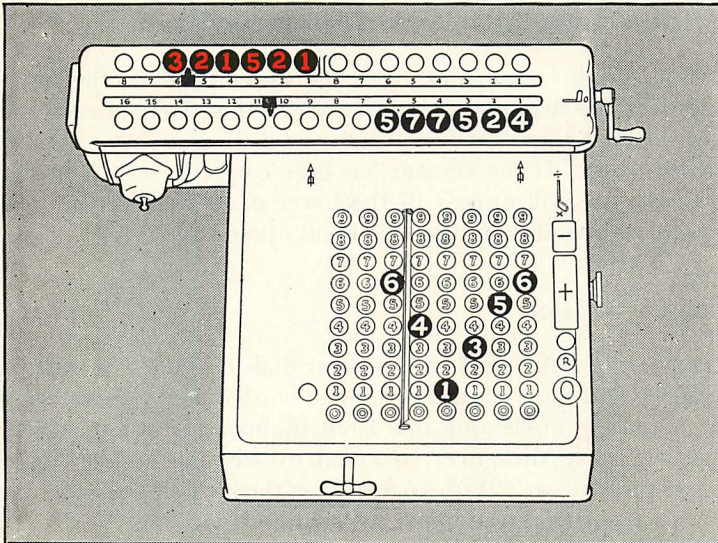**Figure 11**

PART II

Special Problems and Rules for Simplifying and Shortening Certain Operations

The simplicity of the Monroe and the flexibility of every feature make it readily adaptable to a number of short-cuts in the various operations of multiplication and division depending upon the character of the particular problems. We are giving herewith some of these rules. Others of a special nature, depending upon the character of the work that is being done, will be quickly picked up by the operator, or will be suggested, upon request, by the Monroe department which is maintained for that purpose.

Correcting Figures in the Lower Dials

If after a number has been turned into the lower dials it is noticed that one or two figures are incorrect, it is not necessary to clear out all the lower dials to make the correction. Simply leave the incorrect figures on the keyboard, touch the minus bar, subtracting them out, and fill in the correct figures on the keyboard. Much time in correcting errors may be saved in this way, another feature of Monroe efficiency.

Transferring Figures from Lower Dials to Keyboard

In transferring an amount from the lower dials to the keyboard, especially if it is a large one, it is well after setting the figures on the keyboard to subtract them out from the lower dials as a check before going on with the work. If the amount has been correctly set up on the keyboard, zeros only will appear in the lower dials after the subtraction. This safeguard prevents transposition and other errors.

Speeding up Division

In registering a dividend in the lower dials a figure 1 appears in the upper dials. This must always be cleared out before proceeding with the division. Instead of clearing this 1 out by means of the dials clear-out crank, considerable time may be saved by clearing the keyboard and touching the minus bar. With no figures on the keyboard this subtraction will remove the 1 from the upper dials without altering the dividend in the lower dials. The divisor may now be set on the keyboard and the operations of division started immediately.

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Short Cut Multiplication

When a multiplier is a number containing 7's, 8's, or 9's, as for example, 39, 198, 997, the multiplication may be accomplished by a combined use of the plus and minus bars, reducing considerably the number of revolutions required by the regular method.

Example: 2146 x 198 = 424908

Set 2146 on the keyboard, shift the carriage two places to the right, and with the plus bar multiply by 2. In other words, multiply 2146 by 200. Then shift the carriage back two places to its original position, and with the minus bar, subtract 2. The answer, 424908, will then show in the lower dials and the multiplier in the upper dials; in the left upper dials it will appear as 202, i.e., 200 less 2, and in the right upper dials in true figures 198. See Figure 12.
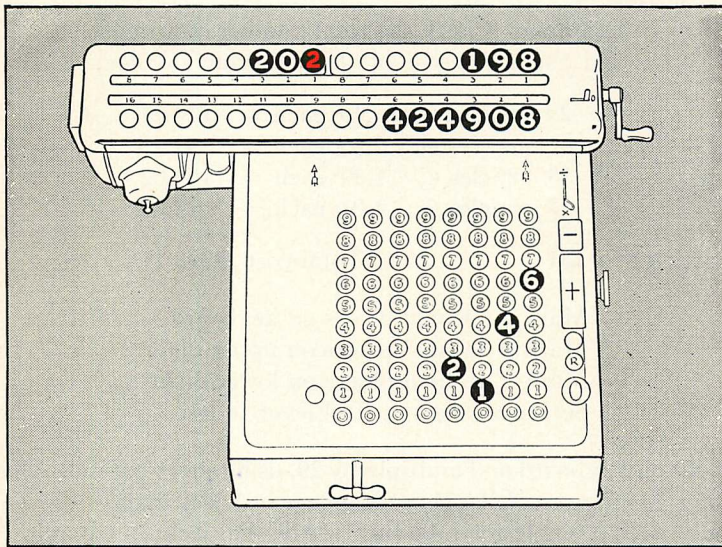

Figure 12

Solving this problem by short-cut multiplication required only four revolutions of the machine, whereas the regular method would require eighteen revolutions.

The operator should practice this method of shortening all multiplications. For example, instead of multiplying by 88, multiply by 100 and take off 12, showing the multiplier in the left upper dials as 112. Instead of multiplying by 2192, show this multiplier in the left upper dials as 2212.

A little practice will enable the operator to become quite proficient in speeding up all multiplications by using cuts such as these:

283 shown in left upper dials as   323, in right upper dials   283
408 shown in left upper dials as   412, in right upper dials   408
827 shown in left upper dials as 1233, in right upper dials   827
2791 shown in left upper dials as 3211, in right upper dials 2791
5987 shown in left upper dials as 6013, in right upper dials 5987

Accumulative Multiplication

The accumulated total of a number of multiplications can be obtained on the Monroe by making one multiplication after another without clearing the lower dials.

Example: Check the total number of articles and the total cost of the following invoice:

29 articles @ $ .49 each = $14.21
41 articles @ 2.25 each =   92.25
58 articles @ 1.89 each =   109.62
 3 articles @ 4.01 each =   12.03

Total articles   131   Total cost $228.11

Mark 2 decimal places on keyboard
Mark 0 decimal places on upper dials
Mark 2 decimal places on lower dials
Set upper dials control lever to left

Set .49 on keyboard and multiply by 29, using short-cut multiplication (30 minus 1); the result, 14.21, will appear in lower dials. Clear upper dials only with a single forward turn of the dial clear-out crank. Note the figures 29 are retained in the right upper dials. Next set 2.25 on the keyboard and multiply by 41, using the left upper dials to register the multiplier. At the end of this multiplication the left upper dials will show the multiplier 41, the right upper dials 70, the accumulation of 29 and 41, and the lower dials 106.46, the accumulation of the result of this multiplication and the result of the previous one. Continue in this manner each multiplication, in each case clearing upper left dials only and allowing figures to accumulate in the right upper dials and lower dials.

At the completion of the last multiplication the total number of articles, 131, is shown in the right upper dials and the total cost, 228.11, in the lower dials, as in Figure 13.
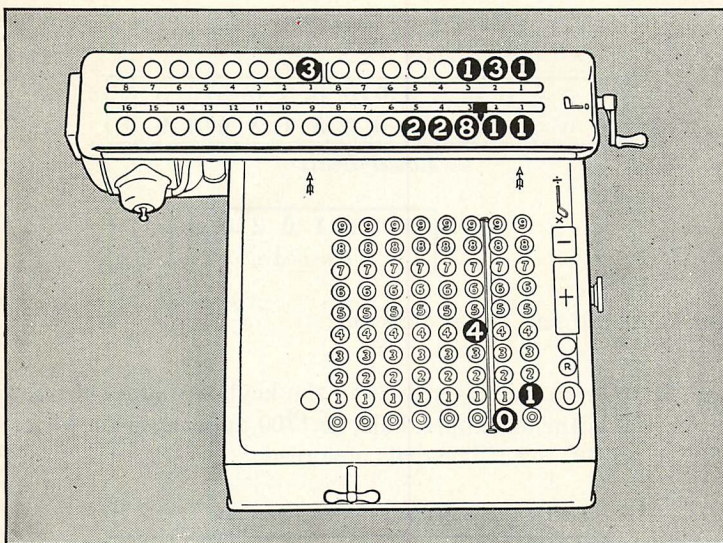

Figure 13

Taking Off Discounts—Chain Discounts

Example: 456 lbs. of copper wire at $0.22½ per lb. less 50–10–5

Mark off two decimal places on keyboard
Mark off three decimal places on both right upper dials and left upper dials
Mark off five decimal places on lower dials

Set 456.00 on the keyboard and multiply by .225, starting with 5 and shifting carriage to the right; the result in the lower dials is 102.60000, the list value.   The dials read:

Left Upper Dials   *Right Upper Dials*

0 0 0 0 0 .2 2 5	0 0 0 0 0 .2 2 5
0 0 0 0 0 0 0 1 0 2 .6 0 0 0 0	

Lower Dials

0 0 0 4 5 6 .0 0
Keyboard

Clear keyboard and upper dials only.

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Set the product, 102.60, on the keyboard and with the minus bar subtract five times, registering the .500 in the correct position in the left upper dials. Disregard figures in the right upper dials. This operation has taken off 50%. The dials now read, disregarding the right upper dials:

Left Upper Dials

```
0 0 0 0 0 .5 0 0 | 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 5 1 .3 0 0 0 0
```

Lower Dials

```
0 0 0 1 0 2 .6 0
```
Keyboard

Clear keyboard and upper dials only.

Copy 51.30 from the lower dials to the keyboard and subtract once, registering .100 in the left upper dials; 46.1700 appears in the lower dials, being 50% and 10% off. The dials now read:

Left Upper Dials

```
0 0 0 0 0 .1 0 0 | 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 4 6 .1 7 0 0 0
```

Lower Dials

```
0 0 0 0 5 1 .3 0
```
Keyboard

Clear keyboard and upper dials only.

Set the 46.17 on the keyboard, shift carriage one place to the left and take off 5% by subtracting 5 times, showing .050 in left upper dials. Final result reads:

Left Upper Dials

```
0 0 0 0 0 .0 5 0 | 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 4 3 .8 6 1 5 0
```

Lower Dials

```
0 0 0 0 4 6 .1 7
```
Keyboard

$43.86 represents the net or total cost, $102.60, less 50–10–5.

Use of Tables for Chain Discounts

When there is any considerable work to be done in taking off chain discounts, it is of course advisable to use a table, which may easily be prepared, showing the equivalents of the discounts most frequently used in a particular class of work. Such tables designed especially for the Monroe Calculating Machine, printed on cards, will be furnished upon application to the Company.

For example, the equivalent of 50–10–5 off is .5725 off and the equivalent of 100% less .5725 is .4275. Knowing this equivalent in the above example the same result may be obtained by simply multiplying the total cost, 102.60, by .4275.

Example: The list price of a certain metal is $6.50 less 50–10–10–5. What is the net price?

Decimal set up: Keyboard five places; right upper dials, two places; lower dials, seven places.

Set the equivalent, .38475, taken from Table of Chain Discount Equivalents (Form 120-S) on the keyboard and multiply it by 6.50, showing the 6.50 in the upper dials. Read the answer, 2.50, in the lower dials.

Reciprocals

When the same divisor is used a number of times, division is shortened by multiplying each dividend by the reciprocal of the divisor. In other words, dividing one number by another is the same as multiplying that number by the reciprocal of the divisor.

The reciprocal of a number is 1 divided by that number. For example, 1 divided by 5 gives the decimal equivalent .2 which is called the reciprocal of 5. Multiplying a number by .2 gives the same result that would be secured by dividing that number by 5, because 5 and .2 are reciprocals.

Reciprocals are used extensively in percentage work and in pro-rating. They form the basis of decimal equivalent tables as used in payroll calculations, cost accounting and many other kinds of mathematical calculations.

Reciprocals Commonly Used

Common reciprocals used in different lines of business which may be memorized if they are used frequently, are as follows:

Month of 28 days	.03571	144 (gross, or inches to sq. ft.)	.006944
Month of 30 days	.03333	240 pence to a pound	.004167
Month of 31 days	.03226	360 days to a year	.002778
32 lbs. to a bushel	.03125	365 days to a year	.00274
56 lbs. to a bushel	.01786	1728 cubic inches to a foot	.0005787
60 lbs. to a bushel	.01667	2240 lbs. to a gross ton	.0004464
12 (dozen)	.08333	5280 feet to a mile	.0001894
16 (ozs. or 16ths)	.0625		

Tables of reciprocals 1–10,000 are published by various authors but their use with the Monroe is unnecessary as reciprocals can be run off on the machine more rapidly and accurately than they can be looked up in tables.

Monroe Method of Finding Reciprocals

With the Monroe the finding of a reciprocal of any number is a simple problem of division.

Problem: Wanted the reciprocal of 144 to six decimal places.

Move the carriage to the right as far as possible. Since the reciprocal of 144 is 1 divided by 144, prefix a 1 to 144 (1144) and set on the extreme left of the keyboard. Turn the 1144 into the lower dials by touching the plus bar. Then by means of the zero clear key of the last column of keys clear the 1 from the keyboard. The machine is now as shown in Figure 14.
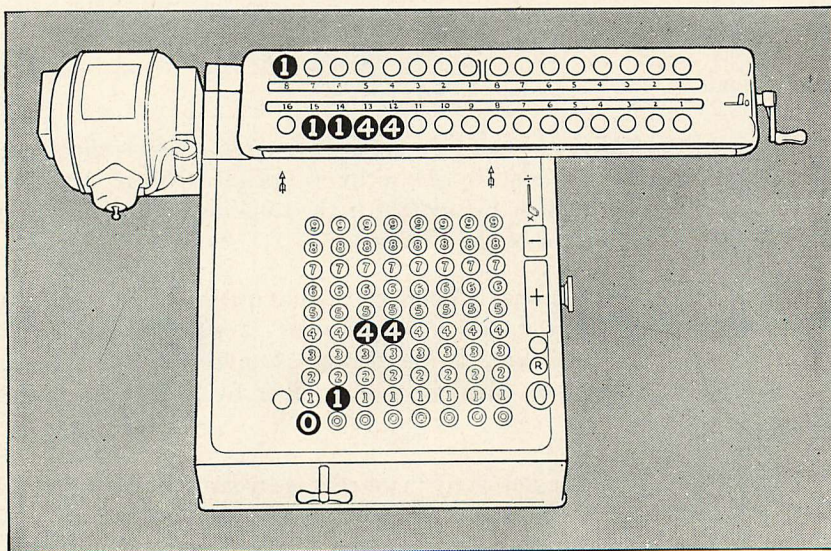

Figure 14

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Without clearing the 1 in the left upper dials, divide, carrying the division out as far as desired.

Note the first reverse revolution of the machine in this division clears the 144 in the lower dials and the 1 in the upper dials so that in reality 1 is divided by 144.

The result of this division, the reciprocal of 144, appears in the left upper dials.

The rule which determines the decimal point in reciprocals is as follows:

"Prefix as many ciphers to the reciprocal as there are whole numbers *less one* in the original number."

The figure 144 having three whole numbers requires two ciphers. Therefore two ciphers are added to its reciprocal, .006944.

Pro-Rating or Distribution

In the following problem the total mileage of three divisions of a railroad and the combined receipts of these divisions are given, it being required to obtain both the percentage and the amount due each division. (The figures in black are the given figures; the figures in red are the required figures as obtained by the operations).

Division	Mileage	Total Receipts	Percentage due each	Amount due each
A	423		.526775	$5101.684
B	234		.291407	2822.204
C	146		.181818	1760.862
	803	$9684.75	1.000000	$9684.750

First add the mileage of the three divisions and obtain the total mileage, 803. Then obtain the percentage due to each division. This may be done either by dividing the mileage of each division by 803 successively or by using the shorter reciprocal method, as follows:

Obtain the reciprocal of 803 which is .00124533 (use method described on page 26).

> Mark off 8 decimal places on keyboard
> Mark off 0 places on upper dials
> Mark off 8 places on lower dials

Set .00124533 on the keyboard and multiply by 423, the mileage of Division A, getting in the lower dials a result of .526775 (52.6775%), percentage due A. Do not clear keyboard or dials. By means of the plus and minus bars change the multiplier to 234 in the right upper dials,

getting in the lower dials .291407 the percentage due B. Again changing the multiplier in the right upper dials to 146 the result .181818, is obtained, percentage due C.

Set these percentages down as they are obtained as shown in the fourth column above.

It is now required to pro-rate the total receipts 9684.75 in the ratio as shown by the percentages.

> Mark off 2 decimal places on keyboard
> Mark off 6 decimal places on right upper dials
> Mark off 8 decimal places on lower dials

Set up 9684.75 on keyboard, and using the percentages just found as multipliers turn them out in the right upper dials, setting down the amount due each division as shown in the fifth column above.

After the last amount 1760.862 is obtained, leave it in the lower dials and add to it the other two amounts to check back to the total 9684.75, thus proving the work. In the problem as worked out, the figures have been carried out sufficiently far to obtain the result correct to a cent. In many cases it is only necessary to obtain results correct to the nearest dollar; in the latter case the work may be considerably shortened by using only four decimal places in the percentage column instead of six places.

If it is required to find only the amounts due each division and not the percentages, the work may be considerably shortened by the following method:

Find the receipts per mile by dividing the total receipts $9684.75 by 803. This gives $12.06071 as the receipts per mile. Set this up on the keyboard as a constant and using the respective mileages as given in the first column as multipliers turn them out in the right upper dials and obtain the amounts due each division directly as shown in the fifth column above.

Interest

Interest may be figured by the ordinary arithmetical rule as follows: Multiply the principal by the rate, then multiply this total by the number of days and divide the total thus obtained by 360 or 365 as the case requires. There are, however, many ways of handling interest calculations on the Monroe, all of which are shorter. Since the rate of 6% and a 360 day year are generally used in figuring interest in most businesses the Monroe "6% method" is given here.

This method of figuring 6% interest on a 360 day basis is as follows: Determine the amount of interest on $1000 for the required number of days by dividing the number of days by 6 and multiply by the principal expressed as a decimal of thousands.

For this work it is well to memorize the decimal equivalents of sixths which are:

$$1/6 = .1667$$
$$2/6 = .3333$$
$$3/6 = .5$$
$$4/6 = .6667$$
$$5/6 = .8333$$

Example: Find the interest on $3575.25 at 6% for 47 days.

Mark off 5 decimal places on keyboard
Mark off 3 decimal places on right upper dials
Mark off 8 decimal places on lower dials

Mentally divide 47 by 6; the result, 7 5/6, expressed as a decimal is 7.8333. This is the interest on $1000 for 47 days.

Set 7.8333 on the keyboard and multiply by the principal, 3575.25, expressed as a decimal of thousands by changing the decimal point 3 places to the left, giving 3.575. (The cents are dropped because they do not affect the answer). The result, 28.00, in the lower dials is the interest.

"Build-up" Division

Division is often accomplished more rapidly when the "Build-up" or "Multiplication" method is used. This is a method which is particularly efficient in the division of large numbers or where a constant divisor or dividend is being used.

The divisor is set on the keyboard and the dividend is built up in the lower dials by a series of multiplications; the quotient appears in the right upper dials.

Example: 7955 ÷ 25 = 318.2

Mark 0 decimal places on keyboard
Mark 1 decimal place on right upper dials
Mark 1 decimal place on lower dials

Set 25 on the keyboard and shift the carriage to the right until the 25 is directly under the lower dials in which the 79 of 7955 is to appear. By means of the plus bar add in the divisor, 25, until the lower dials show a number as near 7955 as possible without exceeding it. Perform this in the following manner:

Shift the carriage into the fourth position and depress the plus bar so that the machine makes three forward revolutions; the lower dials then read 7500.0. This is as much as 25 can be added into the lower dials in

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this position without obtaining a number greater than 7955. Therefore shift the carriage one place to the left and proceed as before. One forward revolution makes the lower dials read 7750.0. Again shift the carriage one place to the left and continue building up by means of the plus bar. Eight revolutions and the lower dials read 7950.0, as near as 7955 can be approximated in whole numbers. By shifting the carriage once more to left and adding in divisor twice the lower dials read 7955.0, the required number. The quotient 318.2 appears in the right upper dials. When the build-up division is completed, the divisor, dividend and quotient, all appear in the machine as shown in Figure 15.
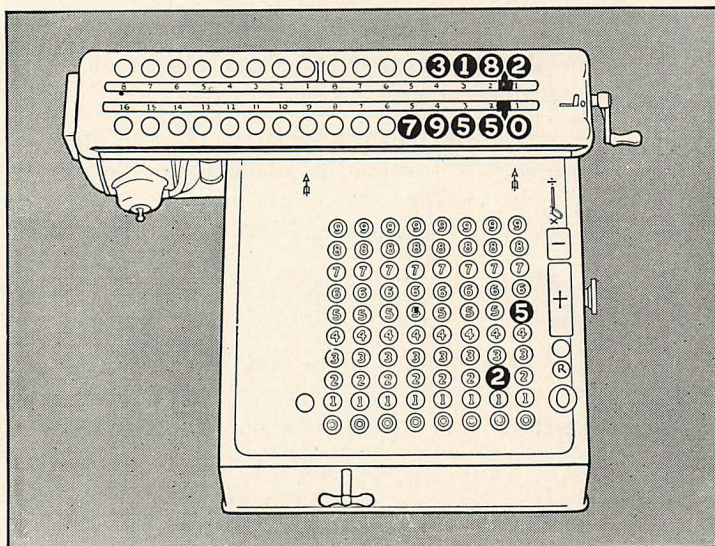
Figure 15

In building up a dividend in this manner the operator must always keep below the required dividend; that is, whenever the number in the lower dials becomes larger than the required dividend the revolutions of the machine should be reversed by the minus bar and the carriage shifted to the next position.

With the Series "3" Monroe this build-up method of division is very speedy because of the tens-carry mechanism of the right upper dials. In building up the dividend, when a number is obtained in the lower dials that is greater than the dividend desired, the carriage is shifted immediately to the left and in the next position with the minus bar subtractions are made until the figures equal or approximate the required number.

Simultaneous Multiplication and Division

Much time can be saved by multiplying the quotient of a division at the same time the division is being made. Multiplication and division are performed simultaneously by building up the dividend at one end of the lower dials, using build-up division, and multiplying the quotient which is being obtained by another number set up at the other side of the keyboard.

> Example: 1728 pieces at $0.26 per dozen.
> Find number of dozen and total cost.

For problems of this kind two sets of decimal points are required on the keyboard and lower dials.

> Mark off 2 decimal places on right upper dials
> Mark off 0 and 8 decimal places on keyboard
> Mark off 2 and 10 decimal places on lower dials
> to correspond to the two keyboard decimal places plus the right upper dials decimal place.

Set 12 on the extreme right of keyboard (1st and 2nd columns). Set .26 on the extreme left of keyboard (7th and 8th columns) keyboard now reads .26000012.

Ignoring the .26 on the left, by means of the plus bar build up 1728.00 in the lower dials from the 12 on the keyboard as explained on page 29. At the completion of the operation the dials read:

Right Upper Dials

0 0 0 0 0 0 0 0	0 0 0 1 4 4 .0 0
0 0 0 0 3 7 .4 4	0 0 1 7 2 8 .0 0

Lower Dials

.2 6 0 0 0 0 1 2
Keyboard

The 144 obtained in the right upper dials by the building up process of division represents the quotient or number of dozens in 1728. The 37.44 represents the product of 144 x .26, or the total cost of 144 dozen.

This method is practical when the numbers involved are not so large as to make the amounts built up in the lower dials run together.

Complementary Division

Complementary division is more practical when simultaneous operations involve large numbers.

Complementary division is subtraction division accomplished by adding the complement of the divisor. The dividend is put in the lower dials. The complement of the divisor is set on the right of the keyboard and the multiplicand *less* 1 on the left of the keyboard. One or more "nine" keys are depressed on the keyboard to connect the two factors.

The number set on the left of the keyboard is always *less* 1 than the actual multiplicand and is connected by nines with the complement of the divisor set on the right of the keyboard. The reason for doing this is that each forward revolution in complementary division carries over a 1 from the dividend. By having the nine keys depressed this 1 is automatically carried over from digit to digit until it finally is added into the figures of the result of the multiplication which is being performed simultaneously. One is dropped from the multiplicand set upon the left of the keyboard to allow for this.

The complement of a number is the difference between that number and the next higher power of ten. Thus the complement of 6 is 4, of 12 is 88, of 73 is 27, of 28 is 72, of 2142 is 7858, etc. To obtain the complement of a number mentally, subtract the right hand digit from 10 and the others from 9. To find the complement of any number on the Monroe put the number on the keyboard and subtract from ciphers in the lower dials by a touch of the minus bar; the number in the lower dials to the right of the nines is the complement of the number on the keyboard.

Using the same example of 1728 pieces at $0.26 a dozen.

Mark off 2 decimal places on right upper dials
Mark off 0 and 8 decimal places on keyboard
Mark off 2 and 10 decimal places on lower dials

Set 1728 on the keyboard and turn into the lower dials in the proper position with regard to the decimal point, i.e. 1728.00. Clear upper dials and keyboard.

At the extreme left of the keyboard set .25. Twenty-five represents one less than 26 cents.

At the extreme right of the keyboard set 88, the complement of 12. Connect the two factors on the keyboard by depressing the nines.

The machine now reads:

Right Upper Dials

```
 0 0 0 0 0 0 0 0 | 0 0 0 0 0 0.0 0
 0 0 0 0 0 0 0 0 0 0 1 7 2 8.0 0
```

Lower Dials

```
.2 5 9 9 9 9 8 8
```
Keyboard

Shift the carriage so that the figures 17 of 1728 in the lower dials are directly in line with the 88 on the keyboard.

Now divide 12 (think of the 88 as 12) into 1728 by depressing the plus bar.

After one forward revolution the dials will read:

Right Upper Dials

0 0 0 0 0 0 0 0	0 0 0 1 0 0 .0 0
0 0 0 0 2 6 .0 0	0 0 0 5 2 8 .0 0

Lower Dials

.2 5 9 9 9 9 8 8
Keyboard

As the result of the division of 1728 by 12 is being obtained in the right upper dials, that result is being multiplied by .26 at the left in the lower dials.

As 12 (88) will not be contained in 5, shift carriage to the left one place. After four forward revolutions in this position the dials are as follows:

Right Upper Dials

0 0 0 0 0 0 0 0	0 0 0 1 4 0 .0 0
0 0 0 0 3 6 .4 0	0 0 0 0 4 8 .0 0

Lower Dials

.2 5 9 9 9 9 8 8
Keyboard

Further forward revolutions cannot be made in this position without bringing up nines over the 88 which would indicate the operation had gone too far. Therefore, shift carriage to the left, continue as above.

After four forward revolutions the dials read:

Right Upper Dials

0 0 0 0 0 0 0 0	0 0 0 1 4 4 .0 0
0 0 0 0 3 7 .4 4	0 0 0 0 0 0 .0 0

Lower Dials

.2 5 9 9 9 9 8 8
Keyboard

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This gives the same result as in the previous example, that is 144 dozen and $37.44 total cost. By this method the 1728 is being cleared out as the other numbers are being built up and therefore the numbers can never run together. Whenever too many forward revolutions are made in any position nines will come up in the lower dials and machine must be reversed by means of the minus bar to correct.

This same method of simultaneous multiplication and division may be applied to various kinds of calculations, as for example:

Find the number of tons and total cost of 5197 pounds at $25.25 per long ton. In this example the capacity of the keyboard is not sufficient to set up the complement of 2240 (7760) the connecting nine and the 25.24. Therefore set up 776 at the right dropping the cipher, 25.24 at left and connect by the nine. The machine then reads:

Right Upper Dials

0 0 0 0 0 0 0 0	0 0 0.0 0 0 0 0
0 0 0 0 0.0 0 0	5 1 9 7.0 0 0 0

Lower Dials

2 5.2 4 9 7 7 6
Keyboard

The change in the decimal points from four to five in the right upper dials is necessary to make allowance for dropping the cipher.

Proceeding as in the previous example the final result is 2.32 tons in the right upper dials and $58.58 total cost in the lower dials, thus

Right Upper Dials

0 0 0 0 0 0 0 0	0 0 2.3 2 0 0 0
0 0 0 5 8.5 8 0 0	0 0 0 0.2 0 0 0

Lower Dials

.2 5 2 4 9 7 7 6
Keyboard

The Monroe Company publishes many interest and other decimal equivalent tables which further help to short-cut and simplify certain types of figuring jobs, also special instructions for applying the Monroe Adding-Calculator. These are furnished free to users and operators. Of the many Monroe publications, the few listed below are those most generally used in ordinary commercial figuring. Any that might be useful in your line of work will be gladly furnished by the nearest local office of the Monroe Calculating Machine Company, Inc., or by the main offices which are in Orange, New Jersey. Requests should mention form numbers.

Form No.	Description
117-S	Decimal Equivalents of Common Fractions—8ths to 64ths
118-S	Fractional Parts of a Gross
120-S	Chain Discount Equivalents
784-S	Chain Discount "Off" Equivalents
855-S	Chain Discount Reciprocal Equivalents
140-S	Tons Expressed as Pounds and Pounds as Decimal of a Ton
127-S	Days Between Dates—for prorata cancellations
159-S	Days as Decimal Equivalent of Year—365 Day Basis Reverse—Days Between Dates
160-S	Same—360 Day Basis
802-S	Same—366 Day Basis
359-S	Trigonometric Functions
360-S	Lumber Table
456-S	Interest on $1,000 for One Day, 1/16% to 12%—360 and 365 Day Basis
539-S	Same—366 Day Basis
662-S	Reciprocals of Interest on $1.00—1/16% to 10%—360 and 365 Day Basis
464-S	Conversion Factors, British-Metric-U. S. Systems
779-S	Table of British Currency
720-S	Monroe Method of Extracting Cube and Higher Roots
769-S	Monroe Method of Extracting Square Root